copper and an iron wire of equal resistance, 1 metre in length, were measured for inductive capacity and resistance, the capacity of the copper wire being taken as 100, and the iron being 400. The copper wire showed an increased resistance, during the variable period, of 8 per cent, as compared with 128 per cent for iron; but a great change took place when each of these was placed in the interior of an iron gas tube of sufficient diameter to allow of the wire being insulated. The force of the extra currents in the copper wire then increased 350 per cent, while in the iron they increased 8 per cent, the force of the extra currents being now, for copper 450, and for iron 433.

The influence of an iron tube on the resistance of the variable period was still more marked. The copper wire which, without the exterior iron tube, had only 8 per cent increase, now showed 934 per cent; or, by direct measurement, 1 metre of this wire, during the rapid rise and fall of the current in the variable period, had a resistance the same as 10.34 metres in the stable period, — a much greater difference than was obtained with iron wire, which only showed an increase of 22 per cent. Thus copper shows three times the sensibility to an iron sheath which iron does, a fact of importance in electrical engineering. Iron is much less affected in self-induction by exterior influence than copper. Copper coils are much more sensitive to iron cores within them than iron coils, and the resistance of a copper coil may be in the variable period far more than that of an equal iron coil, if an iron core react within it. It is this fact, however, as Professor Hughes points out, which enables copper coils to be so effective in transforming energy in 'secondary generators;' and he remarks that a dynamo having its electromagnet and armature wound with insulated iron wire, would, irrespective of its resistance, have an extremely low efficiency as compared with one wound with copper. As regards the resistance of either of those wires, Professor Hughes observes that there can be no doubt that the resistance of the armature of a dynamo, or, in fact, of any coil of wire, as measured during the stable period, gives no approximate indication of what its real resistance is during the period in which it is doing work. This remark bears out a recent suggestion to the effect that the resistances of conductors, apparatus, and standards, as measured by battery currents in the stable period, differ to some extent from their values when traversed by the rapidly fluctuating currents of a dynamo. A further investigation of the matter is required in order to find out its practical importance, if any.

The following table shows the influence of an iron tube surrounding a straight iron or copper wire compared with compound wires: —

WIRES IN IRON TUBE, EACH 1 METRE IN LENGTH.	Comparative electromotive force of the extra currents.	Approximate comparative increased resistance during the variable period (that of the stable period being taken as 1.)
Copper wire 2 millimetres diameter, alone	100	1.08
Same wire insulated in the interior of the iron tube	450	10.34
Same joined in the tube at both ends	275	10.00
Same in contact with the tube throughout its length	200	7.83
Compound wire (copper interior with steel exterior)	325	4.35
Soft Swedish iron, 2 millimetres diameter, alone	400	2.28
Same wire insulated in the interior of the iron tube	433	2.78
Same joined to the tube at both ends	240	2.70
Same in contact with the tube throughout its length	215	2.60
Compound wire (steel interior, copper exterior)	107	1.20

This table shows that the iron tube has a much greater effect on the copper wire than on the iron wire, the effect in both cases being at its maximum when the tube is insulated from its central conducting wire; for, while the wire is in contact with its tube, there is evidently a shunt action, or eddy current, between the outer coating and the central portion. This Professor Hughes has measured by means of a telephone between the wires and its sheath, and also between two concentric sheaths. When the sheath is joined to the wire at both ends, the electromotive force of the extra current is reduced, but the resistance during the variable period is little altered. If, however, as in a coated wire, the wire and sheath are in contact throughout, there is a marked decrease in this resistance. Thus Professor Hughes is of opinion that the shunting effect takes place locally and probably transversely. The passage of an electrical current then takes place with less opposing resistance from self-induction than would be the case if there were no internal partial neutralization of the extra currents.

ORIGIN OF FAT IN ANIMALS.

SINCE the researches of Dumas, Milne-Edwards, and others on insects, and those of Persoz and Boussingault on geese, it has been established that the animal organism has the power of elaborating fatty matters. It was formerly believed that such

matters were received already formed with the food, and that the *rôle* of the animal organism was merely to accumulate them. The vegetable organism, it was thought, was alone able to form them.

In comparing the quantities of fat stored in the bodies of those animals experimented upon with those known to have been introduced with the food, they were found to be considerably greater. It was shown, that, of the thousand grams daily increase in weight of an ox, six hundred or more were due to an accumulation of fat, while the ingested matters contained less than half of that quantity; so that it is rendered certain that a large proportion, if not all, of the fat in the animal body, is due to sources other than fatty foods. What these sources are, is an important question, the answer to which has not been satisfactory. It has commanded much attention, especially in Germany, within late years, and has given rise to numerous controversies. It is a subject, also, of no little importance, since obesity in man is often an infirmity, and sometimes a grave disease. It will therefore be of interest to present such facts, in connection therewith, as have been so far experimentally demonstrated, as given by A. Sanson in the *Revue scientifique*.

Pettenkofer and Voit kept during a number of days, in a suitable respiration apparatus, a dog which received daily given quantities of dried starch and fat, and ascertained that the dog eliminated, under the form of carbonic acid, not only all the carbon of the ingested starch, but also a portion of that of the fat. It was therefore concluded that the starch thus decomposed did not serve in the formation of the fat. This formed the basis of a theory, on Voit's part, that the formation of fat was due to the reduction of albuminoid matters by the oxygen of respiration. According to this theory, the alimentary substances which we call carbohydrates — that is to say, starch, glycogen, sugars — take no part whatever in the formation of fat. These are decomposed in the organism, furnishing material for the animal heat, and resolving themselves into carbonic acid and water. The albuminoid matters — the proteines — are only in part thus decomposed, and furnish, besides, urea and fat.

This theory of Voit, which was in reality a very ingenious hypothesis, was immediately accepted throughout Germany, though Henneberg showed by chemical calculation that 100 grams of albumen thus used would not furnish more than 51 grams of fat in addition to 33 of urea and 27 of carbonic acid. It is necessary to remark, however, that, in the numerous experiments performed by Voit and his disciples in support of this hypothesis, they were not able to verify it directly. It is impossible, in fact, to sustain the life of an animal nourished exclusively by albumen.

Taking as a point of departure the data of Henneberg's calculations and the facts established by the experiments, it has not been difficult to show that Voit's hypothesis is inadmissible by reason of its impossibility. The geese upon which Persoz experimented were found to have formed over 4,000 grams of fat, while their food, completely deprived of fat, contained but 1,400 grams of proteine, — a quantity sufficient to form but a little more than 700 grams of fat. Other experiments of the same nature show the impossibility even in a more striking degree. A cow which gained at the rate of 1,600 grams per day stored up daily nearly 1,000 grams of fat, but an analysis of the food with which she was supplied showed only sufficient albuminoid matters to furnish about half that quantity.

These and other experiments have established reasons, now generally received, for the belief that herbivorous animals do not depend upon albuminous foods for the sources of fat, but that the fat is in a large part derived from the carbohydrates.

Very lately Rübner has repeated the researches of Pettenkofer and Voit, and reached opposite results. He placed in the respiration apparatus a small dog weighing a little more than six kilograms, and gave it food composed of 85 grams of starch, 100 grams of cane-sugar, and 4.7 grams of fat. During ten days, in which it was kept under these conditions, it was found to have eliminated 87 grams of carbon. The entire quantity of carbon introduced by the food was 176 grams, of which 89 were retained in the organism, and served in the formation of fat, 76 of which must have been derived from the carbohydrates. From these facts he concludes that the carbohydrates are demonstrated to be a source of fat in the carnivores as well as in the herbivores and omnivores. These researches of Rübner destroy absolutely the value of those by Pettenkofer and Voit; and one can feel assured that the German theory of the dependence exclusively upon albuminoid matters in the formation of fat in the animal organism will no longer obtain acceptance. In these organisms, as in the vegetable, the fatty matters are formed by the carbohydrates furnished in abundance in the food.

No more definite conclusions, however, in regard to the proper composition of food to produce fattening, can be reached from a knowledge of these facts. In alimentation every thing depends upon digestion. Every thing must be adapted to

the individual aptitude, and the proportions of carbohydrates and albuminoid matters must bear mutual relations dependent more or less upon physiological processes. Too strong or too feeble, as regards the digestive power of the individual considered, the proportion of the carbohydrates exerts an influence either upon its own digestibility or upon that of the albuminoids which accompany it; and in either case it has a depressing effect upon digestion. But, as regards a regimen preventive or remedial of obesity, the case is different. It is evident, that, if the formation of fat is dependent upon carbohydrates, a diet composed largely of them, so often practised, can only be an error so far as obesity is concerned.

A DARING ECONOMIST.

THIS is a day of free lances in political economy. Its doctrines, its premises, its methods, are being subjected to every conceivable kind of criticism; but, of all the kinds, that represented by Mr. Patten's book is perhaps the rarest. He adopts the deductive method of English political economy, and in the main adopts also its premises; but by throwing special emphasis on such of these premises as he conceives have been insufficiently borne in mind, as well as by insisting on some others which he himself introduces, he arrives at most important conclusions very much at variance with those commonly accepted. But it is not so much this position which we have just outlined that makes the book somewhat exceptional, as the fact that Mr. Patten unquestionably understands the doctrines which he criticises. Not only does he understand them, but he gives ample evidence of such logical acumen and practical insight as might fit him to contribute to the improvement and extension of economic knowledge. Yet we are compelled to say that his book, on the whole, is most unsatisfactory; that while a reader who is well versed in economic theory, and who keeps himself constantly on the guard against the author's calm confidence in the completeness of his own argument, may find in it some suggestions which would repay attentive study, to the general reader it is full of snares and pitfalls.

We have touched upon the secret of the author's failure to produce a sound contribution to economic criticism. He seizes upon a feature which seems to him to have been slighted by previous writers; he drags it to the light, and wishes to compel a recognition of its importance in order to give the theory a completeness which it did not before possess; in his eagerness to do this, he comes to look upon his own supplement as the complete doctrine; and what in due subordination to the old teachings might have been a useful idea, becomes in this way a source of confusion and paradox. The author, moreover, exhibits a large share of that quality which has so frequently destroyed the utility of economic writing, — a disposition to exaggerate the differences between his own views and those of previous writers, — and, in his ardent pursuit of the consequences of a pet notion or discovery, loses sight of the principles which he elsewhere shows he has understood. The only safeguard against defects of this sort is a profound sense of one's own liability to err in matters of so subtle and complicated a nature as those with which our author deals, and such a feeling of respect for the great thinkers of the past as would compel one to examine a question most carefully from every point of view before deciding that they were in the wrong. This is not the spirit that animates Mr. Patten: his book is full of bold statements of fact and theory, for which the author seems to think that no further justification is necessary than that they fit in easily with the general considerations which, from his point of view, are most prominent. The result is, that, in addition to a sketchiness and incompleteness quite inconsistent with the weighty character of the subjects discussed, the book is marked by logical oversights of the gravest nature, which almost or quite neutralize the effect of the author's ability.

To justify this estimate of his book by an examination of the several arguments advanced by Mr. Patten would require an amount of space not much less than that occupied by the book itself. We must confine ourselves to one or two illustrations. The first chapter is devoted to a criticism of the Ricardian doctrine of rent. The principal objection here advanced against the theory rests on the fact that the extension of the field of cultivation requires an initial expenditure for clearing the land and fitting it for agriculture. This expenditure will not be incurred unless the owner can expect to receive as rent the ordinary profit on his initial expenditure of capital; but, the expense once incurred, the land will not be withdrawn from cultivation as long as it can merely yield the usual return for the labor and capital annually expended upon it. "It is clear, therefore," says Mr. Patten, "that the laws which regulate the bringing of new lands into cultivation, and those according to which land will be withdrawn from cultivation, are very different, and that there is a large margin within which the

The premises of political economy; being a re-examination of certain fundamental principles in economic science. By SIMON N. PATTEN. Philadelphia, *Lippincott*, 1885. 12°.